NASA-CR-197869

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Grant No. NAG 2-438

Semi-Annual Status Report

September 1994 - February 1995

"Selection of Behavioral Tasks & Development of

Software for Evaluation of Rhesus Monkey

Behavior During Spaceflight"

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(NASA-CR-197869) SELECTION OF BEHAVIORAL TASKS AND DEVELOPMENT OF SOFTWARE FOR EVALUATION OF RHESUS MONKEY BEHAVIOR DURING SPACEFLIGHT Semiannual Status Report, Sep. 1994 - Feb. 1995 (Georgia State Univ.) 5 p

N95-70912

Unclas

Z9/51 0042745

Semiannual Status Report
September, 1994 - February, 1995

Behavior & Performance Project

I. **SUMMARY OF FINDINGS**: The results of several experiments were disseminated professionally during this semiannual period. These peer-reviewed papers and chapters represent follow-up experiments to previously published work or analyses the training data collected over the past few years. The presentations not only reflect the latest interesting results that we have obtained, but also demonstrate the potential for generalization of our findings across monkey-human boundaries.

1. Washburn, D. A. (1994). Stroop-Like Effects for Monkeys and Humans: Processing Speed or Strength of Association? Psychological Science, 5, 375-379. (See Appendix.)

2. Washburn, D. A., & Rumbaugh, D. M. (1994). Training rhesus monkeys (Macaca mulatta) using the Computerized Test System. In J. R. Anderson, J. J. Roeder, B. Thierry, & N. Herrenschmidt (Eds.), Current Primatology (Volume III): Behavioural Neuroscience, Physiology and Reproduction (pp 77-83), Strasbourg, France: Universite Louis Pasteur. (See Appendix.)

3. Rumbaugh, D. M., Savage-Rumbaugh, E. S., & Washburn, D. A. (1994). Learning, prediction, and control with an eye to the future. In M. M. Haith, J. B. Benson, R. J. Roberts Jr., & B. F. Pennington (Eds.), Development of future-oriented processes (pp 119-138), Chicago: The University of Chicago Press. (See Appendix.)

4. Schull, J., Smith, J. D., Washburn, D. A., Shields, W. E. (1994). Uncertainty Monitoring in Rhesus Monkeys. In J. R. Anderson, J. J. Roeder, B. Thierry, & N. Herrenschmidt (Eds.), Current Primatology (Volume III): Behavioural Neuroscience, Physiology and Reproduction (pp. 101-109), Strasbourg, France: Universite Louis Pasteur. (See Appendix.)

5. Hopkins, W. D., & Washburn, D. A., (1994). Do right- and left-handed monkeys differ on cognitive measures? Behavioral Neuroscience, 108, 1207-1212. (See Appendix.)

6. Washburn, D. A., & Gulledge, J. P. (In press). Game-like Tasks: Leveling the Playing Field. Behavior Research Methods, Instruments, & Computers.

Abstract

Game-like computer tasks offer many benefits for psychological research. In this paper, the usefulness of such tasks to bridge population differences (e.g., age, intelligence, species) is

discussed and illustrated. A task called ALVIN was used to assess humans' and monkeys' working memory for sequences of colors with or without tones. Humans repeated longer lists than did the monkeys, and only humans benefitted when the visual stimuli were accompanied by auditory cues. However, the monkeys did recall sequences at levels comparable to those reported elsewhere for children. Comparison of similarities and differences between the species is possible because the two groups were tested with exactly the same game-like paradigm.

7. Washburn, D. A., & Putney, R. T. (1994, October). Visual-Task Performance can Benefit from Secondary-Task Demands. Poster presented at the 38th meeting of the Human Factors and Ergonomics Society, Nashville, TN

Abstract

An experiment was conducted to determine whether attention-switching times would predict visual performance in dual-task environments. Thirteen subjects were tested on a battery of five tasks, where the tasks were presented in random order either alone or in two-task combinations. Response times were not significantly longer for the lexical decision task, the mental rotation task, and the relative numerousness task when paired with a short-term memory task that required continuous vocal rehearsal (mean response time 1106 versus 1026 in the dual-task and single-task conditions, respectively). More surprisingly, however, subjects responded significantly faster on the lexical decision, mental rotation, and relative numerousness tasks when the tasks were embedded within the pursuit tracking primary task than when they were presented alone, $F(1, 144) = 9.44$, $p < .01$. For example, subjects made lexical decisions significantly faster when they had to stop tracking, switch attention to an array of letters, and decide whether the letters constituted a word than when the same task was presented but no tracking was required. Across tasks, response times averaged 1057 msec when tasks were performed individually, but only 909 msec when subjects performed the tasks while pursuit tracking. These data are consistent with previous reports of trial-initiation or procedural difficulty effects. Increasing the difficulty of initiating a trial can elicit a shift in attention that will result in significant improvements in performance. These findings imply that training may be most efficient under conditions of high procedural difficulty, and that vigilance-type tasks might produce better performance if they included a demanding, continuous-response component to elicit and maintain the focus of attention.

8. Washburn, D. A., & Gulledge, J. P. (1994, November). Game-like Tasks: Leveling the Playing Field. Paper presented to the Society for Computers in Psychology, St. Louis, MO.

II. Footpedal training

We have continued with the development of a training protocol that will permit monkeys rapidly to learn to press a footpedal in accordance with varied task demands. With one of our one-year-old monkeys (93-104), this training required the animal first to pull down two overhead rings (to occupy the hands) and then to manipulate a joystick with one foot. The animal was tested in this way with a version of the SIDE task developed for the Rhesus PTS. Because the monkey manipulated the joystick with his left foot, the SIDE task was modified to eliminate single-left-wall trials. The monkey did learn to respond in the SIDE task with his foot, with performance approaching criterion levels established for hand-joystick training. The monkey then demonstrated successful transfer to the CHASE task. Thus, the monkey has learned to control a cursor on a computer screen by manipulating a joystick with his foot. This skill can be used to produce any of a variety of controlled leg movements (e.g., smooth pursuit tracking, speeded responding, stereotyped sequences) because the monkey will respond in accordance with visual stimuli presented on the screen.

At this point, 93-104 was tested with the CHASE task for the ability to respond with a joystick using his hands. He transferred immediately from foot to hand responding. We believe that his CHASE performance was significantly better than would be observed for naive monkeys, and that his foot-to-hand transfer was significantly better than would be observed for hand-to-foot transfer. These hypotheses are the subject of continued investigation.

The joystick has now been replaced with the Bion footpedal. The monkey has learned to press the footpedal so as to bring the cursor into contact with a target in a modified SIDE task (target only on the bottom of the screen). We are currently developing versions of other tasks that will (a) determine the degree of control that 93-104 has over footpedal responding; and (b) instill the specific movements required for flight by the muscle investigator team.

The training procedures used with 93-104 are also being used at our laboratory with a second animal (93-103). Additionally, we have been working with the ARC training staff to initiate training using these procedures with restrained monkeys there.

<u>III. Treadmill training</u>

In December, 1994 we committed to determining whether an efficient training procedure could be devised training young monkeys to walk on a treadmill. In late January of this year, after approval from the Georgia State University IACUC and after the purchase and modification of a treadmill, training began. We are using a motorized treadmill modified with a Lexan enclosure so that the monkey is unrestrained on the treadmill surface. A four-year-old female monkey has learned to walk on the moving belt. We are continuing this training to get the animal (a) to walk either quadrupedally or bipedally, on demand; (b) to walk at a constant pace for longer periods of time; and (c) to control, if possible, the movements of a computer-task cursor using locomotion.

IV. Research Activities

A. Transition to BION project: We have continued to transition our project to the BION platform, searching for ways to maximize science gains. We are developing preflight/postflight performance questions, translating PTS tasks to the footpedal, and coordinating Behavior & Performance experiments with those of muscle physiologists. We have also worked with the ARC training staff to develop an enrichment and training procedure to permit monkeys to learn to use the PTS while being trained for restraint.

B. Analysis of ARRT data: We have received all the data from the ARRT, and have begun to examine the PTS measures in accordance with the Data Analysis Plan. We are looking for changes in learning, memory, attention, perception, psychomotor functioning, and problem solving as a function of restraint condition, and will provide a final report in the next funding period.

C. Continuation of ongoing studies: As evidenced by our publications and presentations during this period, we have continued to test 9 GSU animals on a battery of tasks. These sessions contribute to the corpus of normative and support data required for our science, and highlight the application of NASA-supported technology (the PTS) for basic cognitive science and human factors research. Experiments in attention, learning and memory, stimulus equivalence, numerical competence, motivation, and psychological well-being are ongoing.